What is claimed is:

1. A method for registering the actual description MI of an object under measurement with a nominal description MS of the object under measurement, the actual description MI describing the actual geometric dimensions, the actual position and the actual orientation of the object under measurement, and defined geometric dimensions, a defined position and a defined orientation being specified via the a nominal description MS for the object under measurement, comprising the steps of:

measuring elements of the actual description MI, with elements of the nominal description MS being predefined, and

determining a transformation T for aligning the object under measurement according to the nominal description, the determining of the transformation including:

1. determining an initial transformation T_{init} for mapping the actual description MI, so as to define a transformed actual description MIt, and mapping the nominal description MS with the inverse T_{init}^{-} of initial transformation T_{init}, so as to define a transformed nominal description MSt,
2. determining target elements from the nominal description MS for selected elements of the transformed actual description MIt, and determining target elements from the actual description MI for selected elements of the transformed nominal description MSt,
3. that the target elements of MIt are transformed with the inverse T_{init}^{-} and form the target elements for the selected elements of the actual description MI; and in that the target elements of MSt are transformed with the initial transformation T_{init} and form the target elements for the selected elements of the nominal description MS,
4. that, for determining the quality of the transformation T_{init}, both a scalar clamping error is determined from the determined selected elements of the transformed actual description MIt and corresponding target elements of the nominal description MS, and a scalar clamping error is determined from the determined selected elements of the actual description MI and corresponding

target elements of the transformed nominal description MSt,

5. by modifying the transformation T_{init} as a function of its quality in an exploratory method, and by proceeding with the modified transformation according to steps (1) through (5) until a termination criterion for the exploratory method is reached.

2. The method as recited in Claim 1, wherein spatial points P_{si} are selected as elements of the nominal description MS and spatial points P_{li} are selected as elements of the actual description MI.

3. The method as recited in Claim 2, wherein at least one of the specified spatial points P_{si} of the nominal description MS is allocated a specified spatial direction R_{si} so that the nominal description MS includes a spatial direction R_{si} at least for one spatial point P_{si}.

4. The method as recited in Claim 2, wherein a spatial direction R_{li} is determined for at least one of the determined spatial points P_{li} of the actual description MI so that the actual description MI includes a spatial direction R_{li} at least for one spatial point P_{li}.

5. The method as recited in Claim 3, wherein at least one spatial point P_{si} of the nominal description MS lies in one of the defined surfaces of the object under measurement; and this spatial point P_{si} is allocated the normal to the defined surface of the object under measurement in the spatial point P_{si} as spatial direction R_{si}.

6. The method as recited in Claim 3, wherein at least one spatial point P_{li} of the actual description MI lies in one of the determined surfaces of the object under measurement; and this spatial point P_{li} is allocated the normal to the determined surface of the object under measurement in the

spatial point P_{li} as spatial direction R_{li}.

7. The method as recited in Claim 2,
wherein at least one of the specified spatial points P_{si} of the nominal description MS is allocated at least one feature element so that the nominal description MS includes a feature element at least for one spatial point P_{si}.

8. The method as recited in Claim 2,
wherein at least one feature element is determined for at least one of the determined spatial points P_{li} of the actual description MI so that the actual description MI includes a feature element at least for one spatial point P_{li}.

9. The method as recited in Claim 8,
wherein the feature element is a geometric feature element.

10. The method as recited in Claim 9 wherein the geometric feature element is a circle, a cylinder, a sphere, or a plane.

11. The method as recited in Claim 1,
wherein a unit matrix is specified as initial transformation T_{init}.

12. The method as recited in Claim 1,
wherein the initial transformation T_{init} is determined automatically on the basis of predefined pairs of corresponding elements of the nominal description MS and the actual description MI.

13. The method as recited in Claim 2,
wherein a nominal centroid S_s is determined from specified spatial points P_{si} of the nominal description MS; a actual centroid S_l is determined from the determined spatial points P_{li} of the actual description MI; and a translation of the actual centroid S_l

onto the nominal centroid S_s is determined as the initial transformation T_{init}.

14. The method as recited in Claim 7,
wherein a translation or a rotation between corresponding feature elements of the actual description MI and the nominal description MS are determined as the initial transformation T_{init}.

15. The method as recited in Claim 1,
wherein
– initially, for determining corresponding elements of two descriptions of the object under measurement, elements of one of the two descriptions are selected which constitute the selected elements while the elements of the other description constitute the target set,
– each selected element is allocated at least one control parameter with the aid of which an individual subset of the target set is determined for each selected element,
– for each selected element, a target element is determined from the previously determined individual subset of the target set on the basis of additional information on the geometric configuration of the object under measurement.

16. The method as recited in Claim 15,
wherein the control parameter is used to describe the shape of a search volume and its position relative to the selected element; and the elements of the target set which are contained within the search volume constitute the required subset of the target set.

17. The method as recited in Claim 16,
wherein a cylinder, a sphere, or a cube are selected as the search volume.

18. The method as recited in Claim 15,
wherein the additional information on the geometric configuration of the object under

measurement exists in the form of a CAD description or in the form of feature information.

19. The method as recited in Claims 15,
wherein
- the selected element is a spatial point P_v,
- the target set is a set of points,
- the spatial point P_v is allocated a search volume as control parameter,
- the points of the target set which lie within the search volume are determined as the individual subset of the target set for the spatial point P_v,
- the target element, spatial point P_z, of the spatial point P_v is determined from the points of the individual subset in that a surface is fitted into the points of the individual subset as a model of the object under measurement.

20. The method as recited in Claim 19,
wherein the spatial point P_v is allocated a spatial direction N_v; and target element P_z is determined as the point of the subset which lies closest to the projection of the spatial point P_v along the spatial direction N_v onto the plane.

21. The method as recited in Claim 19,
wherein a plane E is selected in the search volume as a model of the object under measurement.

22. The method as recited in Claim 21,
wherein the target element P_z is allocated the orientation R of the plane E as spatial direction N_z or, in general, each usable directional information which can be derived from the subset of the target set.

23. The method as recited in Claim 18,
wherein the target element P_z is allocated a directional information which is derived

from the subset of the target set.

24. The method as recited in Claim 20,
wherein the target element P_z is determined as the point of the subset which is closest to the base point of the perpendicular line of the spatial point P_v onto the plane E.

25. The method as recited in Claim 20,
wherein the spatial point P_v is allocated the spatial direction N_z if no spatial direction was allocated to the spatial point P_v.

26. The method as recited in Claim 2,
wherein the scalar clamping error F between two descriptions of the object under measurement is determined by

1. determining a vectorial difference A_i for each pair of corresponding spatial points,
2. selecting at least one vector component of the vectorial difference A_i as representative differential vector D_i and
3. determining the length of the differential vector D_i as the scalar distance error for the respective pair of corresponding spatial points.

27. The method as recited in Claim 26,
wherein the distance error determined for each pair of corresponding spatial points is weighted with a weighting factor Ga_i.

28. The method as recited in Claim 26,
wherein, given a coordinate system K, the vectorial difference A_i is expressed in the vector components which lie in one of the main planes of the coordinate system KXY, KYZ, and KXZ and/or along one of the axes KX, KY, and KZ of the coordinate system.

29. The method as recited in Claim 26,
the spatial points of at least one of the two descriptions being allocated spatial directions,
wherein the vectorial differences A_i between the pairs of corresponding spatial points are each expressed
    1. in a vector component AN_i perpendicular to the plane which is defined by the corresponding spatial point and the spatial direction allocated thereto,
    2. and in a vector component AL_i lying within this plane.

30. The method as recited in Claim 29,
wherein the vectorial difference A_i is allocated a positive sign,+1, if the spatial point corresponding to the spatial point which defines the plane lies above this plane, and a negative sign,-1, if the spatial point corresponding to the spatial point which defines the plane lies underneath this plane.

31. The method as recited in Claim 26, wherein
the spatial points of both description are allocated spatial directions,
wherein an angle error w_i is determined for each pair of corresponding spatial points.

32. The method as recited in Claim 31,
wherein the angle error w_i is weighted with a weighting factor Gw_i.

33. The method as recited in Claim 27,
wherein the scalar clamping error F_i for a pair of corresponding points is determined as

$$F_i = Ga_i \bullet \text{length}(D_i) + Gw_i \bullet w_i$$

34. The method as recited in Claim 2,
wherein the scalar clamping error F_i between a pair of corresponding spatial points of two descriptions of the object under measurement is assumed to be zero ($F_i = 0$) if

1. the vectorial difference A_i for this pair of corresponding spatial points cannot be determined, or
2. if no vector component of the vectorial difference A_i can be selected as representative differential vector D_i or
3. if the length of the differential vector D_i cannot be determined as scalar distance error.

35. The method as recited in Claim 26,
wherein the scalar clamping error F between two descriptions of the object under measurement is determined as the mean square deviation from the scalar clamping errors F_i related to the expected value zero, the smallest possible error measure for a pair of corresponding spatial points

$$F = \mathrm{SQRT}(\mathrm{SUM}(1, n, Ga_i \bullet \mathrm{length}(D_i)\bullet \mathrm{length}(D_i) + Gw_i \bullet w_i \bullet w_i))) / \mathrm{SUM}(1,n,(Ga_i + Gw_i))$$

where n is the number of pairs for which a clamping error F_i could be determined.

36. The method as recited in Claim 26,
wherein the scalar clamping error F between two descriptions of the object under measurement is determined as the mean deviation from the absolute values of the scalar clamping errors F_i

$$F = \mathrm{SUM}(1, n, (\mathrm{ABSOLUTE\ VALUE}(Ga_i \bullet \mathrm{length}(D_i)) + \mathrm{ABSOLUTE\ VALUE}(Gw_i \bullet w_i))) / \mathrm{SUM}(1,n,(Ga_i + Gw_i))$$

where n is the number of pairs for which a clamping error F_i could be determined.

37. The method as recited in Claim 26,
wherein the scalar clamping error F between two descriptions of the object under measurement

measurement is determined as the maximum deviation from the absolute values of the scalar clamping errors F_i

$$F = \text{MAXIMUM}(\text{ABSOLUTE VALUE}(F_1), (\text{ABSOLUTE VALUE}(F_2), \ldots, (\text{ABSOLUTE VALUE}(F_n)$$

where n is the number of pairs for which a clamping error F_i could be determined.

38. The method as recited in Claim 26,
wherein the scalar clamping error F between two descriptions of the object under measurement is determined as the maximum positive deviation of the scalar clamping errors F_i

$$F = \text{MAXIMUM}(F_1, F_2, \ldots, F_n)$$

where n is the number of pairs for which a clamping error F_i could be determined.

39. The method as recited in Claim 26,
wherein the scalar clamping error F between two descriptions of the object under measurement is determined as the maximum negative deviation of the scalar clamping errors F_i

$$F = \text{MINIMUM}(F_1, F_2, \ldots, F_n)$$

where n is the number of pairs for which a clamping error F_i could be determined.

40. The method as recited in Claim 1,
wherein an interval halving is carried out as the exploratory method for modifying the transformation T_{init} and the subsequently resulting transformations.

41. The method as recited in Claim 1,
wherein a gradient analysis is carried out as the exploratory method for modifying the transformation T_{init} and the subsequently resulting transformations.

42. The method as recited in Claim 1,
wherein a Newtonian method for zero point determination is carried out as the exploratory method for modifying the transformation T_{init} and the subsequently resulting transformations.

43. The method as recited in Claim 1,
wherein a Fourier analysis is carried out within the scope of the exploratory method for modifying the transformation T_{init} and the subsequently resulting transformations.

44. The method as recited in Claim 1,
wherein a maximum number of modifications of the transformation is specified as termination criterion for the exploratory method.

45. The method as recited in Claim 1,
wherein a value for the clamping error is specified as termination criterion for the exploratory method.

46. The method as recited in Claim 1,
wherein the exploratory method is terminated when a predefined number of modifications of the transformation has not resulted in a reduction of the clamping error.